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Fishery Leaflet 14

Chicago 54, Ill. Rev. November 1946

PACIFIC SALMONS

Prepared in the Division of Fishery Biology

Five species of salmon belonging to the family Salmonidae and the genus Oncorhynchus inhabit the waters of the Pacific coast of North America. These are O. tschawytscha, the chinook or king salmon; O. kisutch, the silver or coho salmon; O. gorbuscha, the pink or humpback salmon; O. keta, the chum or dog salmon; and O. nerka, the red, sockeye, or blueback salmon.

The five salmons of the American shores of the Pacific occur also in the western Pacific, generally from Kamchatka to the Island of Hokkaido in the northern part of Japan. In addition, a sixth species, called "masu" (O. masu) in Japan, is found from southern Japan to the Island of Sakhalin. The masu is a very important commercial fish in Japan, although it is less valuable than any one of the five species of American salmon.

GENERAL LIFE HISTORY

All species of Pacific salmon are anadromous, that is, the adults migrate from the ocean into fresh water to spawn. The parent fish deposit the eggs in nests which they have dug in the gravel of the stream or lake bed and the eggs are covered with gravel to a depth of several inches. Newly hatched fish bear on their abdomens a yolk sac filled with nutritive matter which was contained with them in the egg. These young or larval salmon live in the gravel of the nest for about a month, living on the yolk which they gradually absorb. At the end of this period they wriggle up into the waters of the stream or lake and begin to find food. The length of the period of fresh-water life varies greatly with the species, but at its conclusion all young salmon migrate downstream to the ocean. There they remain for one to several years, feeding and growing rapidly. When they attain physical maturity they return to fresh water to spawn.

No species of Pacific salmon spawns more than once in its lifetime. There is conclusive evidence of this fact from scale examinations and from direct observation. Moreover, all Pacific salmon die within a short time after spawning, hence they never return to the ocean after running into the rivers, with the exception of a few of those that spawn near the sea and drift downstream to the ocean to die.

The number of eggs produced by Pacific salmon varies greatly with the species and the size. Pink salmon average about 2,000 eggs per female; chum salmon 3,000 eggs; red salmon 3,500 eggs; silver salmon 3,500 eggs; and chinook salmon 5,000 eggs.

All species of Pacific salmon feed on plankton (small floating plants and animals) during the early stages of life. The red, chum, and pink salmon feed largely on plankton including the larger copepods and shrimps throughout their entire existence. King and silver salmon subsist largely on insects and occasional small fishes during their life in fresh water and on candlefish, herring, and other small species during their ocean residence. With the exception of a few known instances of adult king salmon feeding in the lower part of a river, no species of Pacific salmon feeds while on its spawning migration in fresh water.

All available data indicate that a high percentage of the Pacific salmon return as adults to the same stream from which they migrated to the ocean as fingerlings. If young salmon are transplanted from one river to another, they return as adults to the stream in which they were planted and not to the one from which the eggs came. For instance, eggs of Alaska salmon have been shipped to the Columbia River where they were hatched, reared, and liberated. At the age of about 18 months the young migrated to the ocean, where they remained for 2 or 3 years and then returned to the Columbia River. Marking experiments have shown that only slight straying occurs. Consequently, in regulating the salmon fishery the population in each river system must be considered as a unit and given adequate protection in order to avoid depletion.

In stating the age of salmon, one usually refers to the number of calendar years that have elapsed since the parents of that salmon spawned, or the number of years that elapsed from one generation to another. The age of the fish therefore is reckoned in years, not months. For example, let us assume that a run of salmon enters a river to spawn in July of a given year, the eggs from those fish hatch in due course, and the young emerge from the gravel in April of the next year. They later proceed to the ocean where they remain until July of the following year, then return to the river to spawn. These progeny from the original spawning fish would actually be about 15 months old. However, they would be referred to as having stayed in the ocean 1 year and would be called 2-year fish because 2 calendar years had elapsed between the time the eggs were laid and the time the fish reached maturity.

Salmon are important both as commercial and as game fish. They are taken by trollers and purse seiners on the high seas, by fish traps, seines and gill nets in the coastal waters, and by drift and anchored gill nets in the larger rivers. The flesh of the salmon very rich in proteins, fats, and vitamins is highly suitable for canning. Although large quantities are sold on the fresh-fish markets and considerable amounts are frozen, pickled and smoked, the bulk of the annual catch is canned.

Chinook and silver salmon are highly prized by sportsmen, thousands of whom troll, spin, or cast for them in the coastal bays and streams.

Salmon fishing by anglers is carried on throughout the greater part of the year, resulting in the capture of immature and mature fish, but the greatest catches are made during the period of abundance of the mature fish.

CHINOOK OR KING SALMON (O. tschawytscha)

Range and distribution. - Chinook salmon are found from Monterey Bay, California, to the Yukon River and from Bering Strait to the southern Siberian coast. Exotic runs, through transplantation of fertilized eggs, have been established in the St. Lawrence River and on South Island, New Zealand. The Columbia and Sacramento-San Joaquin Rivers carry the largest runs of the species while Puget Sound, British Columbia, and southeastern Alaska are also important producing areas.

Life in fresh water. - The life of the chinook salmon in fresh water is quite variable. Some groups or races remain in fresh water only a few days or possibly hours after emerging from the gravel, while others do not migrate to the sea until their second year of life. It is possible that some chinook salmon do not enter the sea until the beginning of their third year; however, this appears to be a rare occurrence. The chinook salmon does not appear to have a "landlocked" form, although in some instances young individuals, placed in lakes where they could not reach the ocean have lived their entire life in the lakes and grown to large size.

Life in ocean. - The time spent in the ocean by chinook salmon normally varies from one to four years.

Age at maturity. - The total age at maturity is variable, ranging from two years, for precociously mature males, to seven years. Individuals as old as nine years have been reported, but the majority mature when from three to five years of age.

Length and weight. - Chinook salmon have an extremely wide range in both length and weight at maturity. Some precocious males mature when only about 16 inches long and a few exceptional individuals have been known to reach a length of almost 60 inches. The average length, however, is about 36 inches. Their weight may be as little as 2-1/2 pounds and as great as 100 pounds. Fish of 40 to 60 pounds are not extremely rare, but the average is about 23 pounds.

Time of run. - The chinook salmon is also exceedingly variable in its time of entry into fresh water for the purpose of spawning. In most streams the principal migrations occur at some time between early spring and early fall. The late summer and fall runs are usually the most numerous. In the Columbia River a few chinooks are present even during the winter months.

RED, SOCKEYE, OR BLUEBACK SALMON (O. nerka)

Range and distribution. - Red salmon occur from the Columbia River to the Yukon River and from Bering Strait to Japan, being present within this range in nearly all rivers having accessible lakes in the watershed. Bristol Bay in Alaska is the greatest producing area of this species in the world. Other important producing regions occur in British Columbia, Alaska, and Siberia.

Life in fresh water. - The eggs are deposited in the gravels of the nest during the summer and fall and the young hatch out in the spring of the following year. After hatching the young red salmon spend from a few months to four years in a lake. In the southern part of the range the period of fresh water residence is usually one year, in the northern part of the range usually two or three years.

"Landlocked" populations are rather frequent in the southern part of the range. These fish never go to the ocean but in all other respects, except size, are identical with the sea-run populations. They are usually called "silver trout," "little red fish," or "kokanee."

Life in ocean. - Red salmon migrate to the ocean in the spring and remain there from a few months to four years, usually two years in the southern part of the range and two or three years in the northern part of the range.

Age at maturity. - The total age at maturity, including the period of incubation, varies from three to eight years, usually four years in the southern part of the range and five or six years in the northern part of the range.

Length and weight. - This species ranges from 15 to 30 inches in length, averaging about 25 inches, and from 2 to 10 pounds in weight, averaging about 6 pounds.

Time of run. - The time of the run varies in different localities. The first fish usually appear as early as May and the run may continue until October. However, the peak of the run to a given river usually occurs during a three or four week period except in those localities which have more than one distinct population. The main body of the Fraser River run usually appears during the last two weeks of July and the first two weeks of August. The main body of the Copper River run appears during June. Karluk and Chignik Rivers have two runs, one in June and one in August and September. In Bristol Bay the main body of fish appears between the last week of June and the first three weeks of July.

COHO OR SILVER SALMON (O. kisutch)

Range and distribution. - Silver salmon are found in the coastal areas of the Pacific Ocean from Monterey Bay, the southern limit of their

range northward to Kotzebue Sound in the Bering Strait, and in the Asiatic waters as far south as Japan. Several attempts have been made to establish this species on the Atlantic coast and in foreign countries by stocking with fertilized eggs. A successful transplantation of silver salmon has been reported in Chile where the conditions of the ocean and streams are favorable for this species. Although silver salmon are distributed throughout the North Pacific the largest populations are found in the streams of Oregon, Washington, British Columbia, and southeastern Alaska.

Life in fresh water. - About three months (depending on the water temperature) after the eggs are deposited, the small fish hatch. During the next month they absorb the nutritive yolk sac, then wriggle up through the gravel to become free-swimming inhabitants of the stream. Following their emergence from the gravel in the spring months the young silver salmon feed on aquatic insects in the streams and gradually move downstream toward the ocean. Most of these young remain in the streams throughout the following winter, at which time they are about four inches in length. In the more northerly part of the range about half of the young remain in fresh water a second year. Silver salmon have been stocked in many landlocked lakes to increase sport fishing but self-perpetuating populations have been reported from only one such area.

Life in ocean. - Following their seaward migration the silver salmon feed voraciously and grow rapidly in the ocean where practically all of them remain one year.

Age at maturity. - A few male silver salmon mature precociously at two years of age. In the Puget Sound district nearly the entire run is made up of fish in their third year, while in central and western Alaska the runs are composed of about equal numbers of fish in their third and fourth years.

Length and weight. - During their residence in the sea the weight of these fish is increased from the initial few ounces to as much as 30 pounds. At maturity they average about 9-1/2 pounds in weight and about 24 inches in length.

Time of run. - Adult silver salmon ascend nearly all of the coastal streams and rivers in the fall of each year on their spawning migration. The time of the run and the length of the spawning season throughout the entire range of the species varies considerably but occurs chiefly from September to December.

PINK OR HUMPBACK SALMON (O. gorbuscha)

Range and distribution. - Pink salmon are found from the Columbia River to Bering Sea and on the Siberian coast from Bering Strait to northern Korea. Important producing areas include Puget Sound, British Columbia, southeastern and central Alaska and central Siberia. Southeastern Alaska, however, is the center of abundance, producing a pack greater than that of all other areas combined.

Life in fresh water. - The eggs are deposited in the gravels during the summer and fall and the young hatch during the following spring. The fry emerge from the gravel about the time the yolk sac is absorbed and immediately migrate to salt water.

Life in ocean. - Pink salmon invariably remain one year in salt water.

Age at maturity. - This species is unique in that it matures uniformly at two years of age. Each stream which bears an annual run thus supports two independent populations of fish.

Length and weight. - Pink salmon average approximately 18 inches in length and 4 pounds in weight.

Time of run. - The time of the run varies somewhat in different localities, but in general is earlier in the more northerly part of the range. On Puget Sound and in British Columbia the bulk of these fish are taken from mid-August to mid-September, in southeastern and central Alaska during July and August, and in western Alaska from mid-June throughout July.

Pink salmon are also unique among the Pacific salmons in that they show marked and consistent differences in abundance in odd and even-numbered years in certain parts of their range. For the most part this has been a continuation of a condition existing prior to the inception of the commercial fishery. The cause of this condition is unknown but its continuation is a natural accompaniment of the unvarying age at maturity and the relatively high degree of the homing instinct of this species. In Puget Sound area millions of pink salmon appear in odd-numbered years, while the runs in even years number only a few thousands. In southeastern and central Alaska no consistent variation appears in the runs from year to year. In western Alaska moderate runs appear in the even-numbered years and practically no pink salmon are found in the odd years. Throughout the greater part of Siberia heavy runs appear in even-numbered years and very few in odd years; however, in the southern part of this district (Tartar Strait) considerable numbers of pink salmon do appear in the odd-numbered years.

CHUM OR DOG SALMON (O. keta)

Range and distribution. - Chum salmon are found from the Oregon coast to Bering Strait, in the eastern Arctic Sea to the Lena River, and along the Siberian coast south to the Tumen River, Korea, and northern Honshu Island, Japan.

Life in fresh water. - The eggs are usually deposited in the gravels during the summer and fall months and the young hatch during the following spring. About the time the yolk sac is absorbed the fry wriggle out from the gravel and migrate to the sea.

Life in ocean. - From 18 months to 4 years are spent in salt water.

Age at maturity. - A few chum salmon mature at two years of age, but the bulk of these fish mature at three to five years.

Length and weight. - This species averages at maturity approximately 25 inches in length and 9 pounds in weight. Occasionally very large individuals, weighing as much as 45 pounds, have been reported.

Time of run. - The chum runs extend from spring to late fall in various portions of the range, but the bulk of the runs occur during the fall months. In Puget Sound chums do not appear in significant numbers before late September and the main run occurs between October 1 and November 15. In Alaska the runs begin during mid-summer and extend into the fall months. In Siberia a distinctive summer run appears in June and July and a fall run in September, October, and November.

COMMERCIAL IMPORTANCE OF SALMON

All of the Pacific salmons are of great commercial importance and value. The landings and wholesale market values of these species during 1943 and 1944 in the Pacific Coast States and Alaska are shown in the following tables. (Data for two years are presented to indicate the fluctuation in numbers of pink salmon in odd- and even-numbered years.)

Complete figures are not available for the Siberian salmon catch in these years, hence they are not presented in these tables. More than 230,000,000 pounds of salmon were canned in each of these two years, of which approximately 45 percent were pink salmon and 35 percent red salmon. The value has been determined on the basis of the wholesale market value of the catch.

Table 1. - Catch of Pacific salmon in the United States and Alaska, 1943

Species	Alaska		Pacific Coast States	
	Pounds	Value	Pounds	Value
Coho	22,173,102	$2,900,662	9,584,700	$1,315,493
Chum	77,690,088	7,661,075	6,575,800	436,521
Pink	186,801,852	18,237,875	5,594,000	279,851
King	12,591,220	2,090,006	25,469,000	4,241,055
Red	158,050,560	29,886,061	1,876,600	302,136
Total	457,306,822	60,775,679	49,100,100	6,575,056

Table 2. - Catch of Pacific salmon in the United States and Alaska, 1944

Species	Alaska		Pacific Coast States	
	Pounds	Value	Pounds	Value
Coho	22,844,040	$3,156,374	11,538,400	$1,293,877
Chum	83,795,856	8,040,408	4,460,900	327,659
Pink	155,544,568	16,792,698	24,600	1,233
King	10,124,780	1,602,819	31,380,264	4,626,818
Red	121,009,230	24,202,427	2,164,600	346,344
Total	393,318,474	53,794,726	49,568,764	6,595,931

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NOTE: Publications which are out of print are available for reference in many university and public libraries, especially those that are Government Depositories.